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(54) **JOINT STRUCTURE FOR VEHICLE BODY MEMBER, AND VEHICLE BODY STRUCTURE**

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See application file for complete search history.

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(Continued)

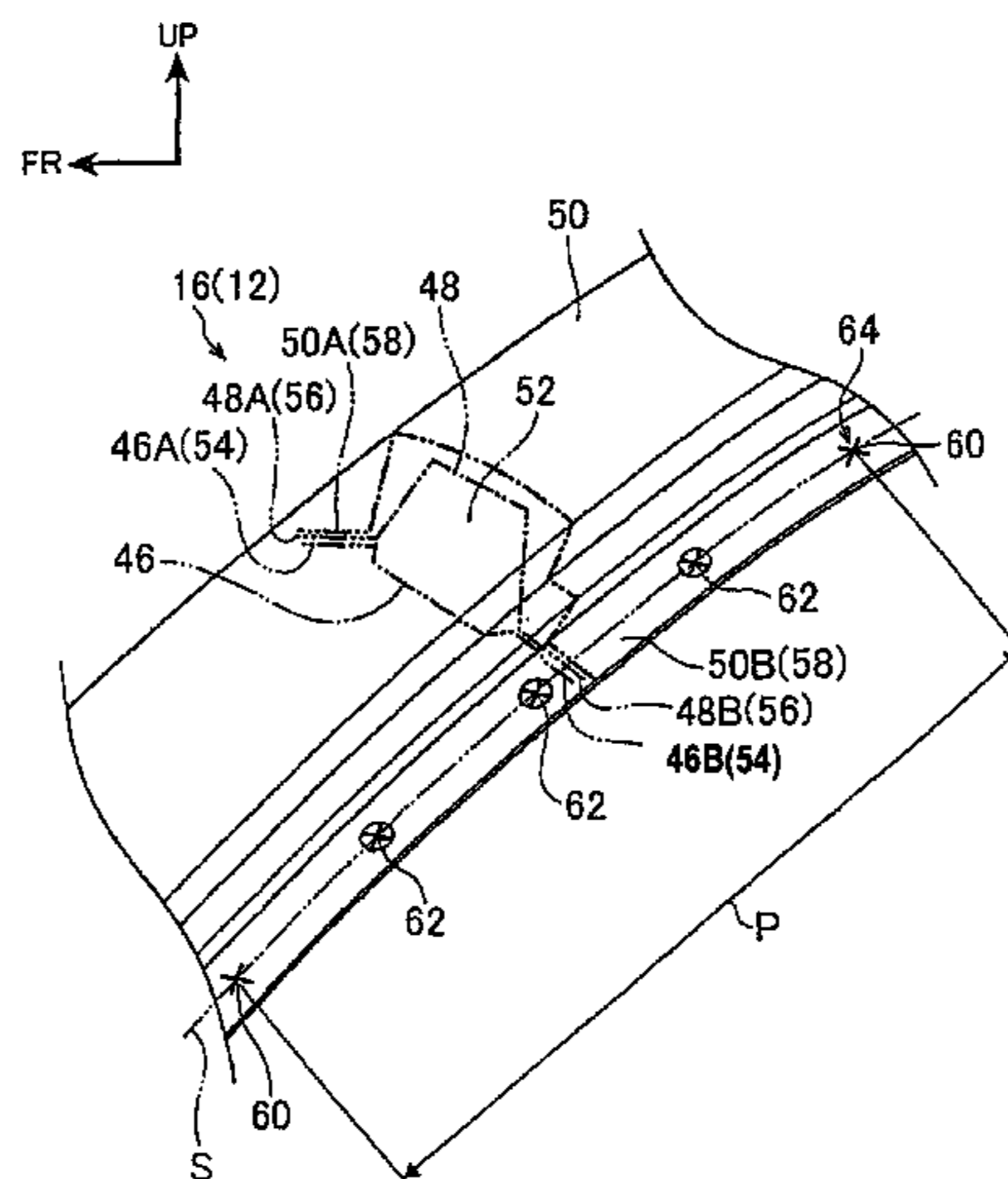
(57) **ABSTRACT**

A joint structure for a vehicle body member, the vehicle body member including at least two panel members, the at least two panel members constituting part of a vehicle body and being formed of a steel plate, the joint structure includes: spot-welds formed by spot-welding the at least two panel members to each other at a predetermined spot interval such that a predetermined clearance is formed between the at least two panel members; a laser-weld formed by laser-welding the at least two panel members to each other between the spot-welds; and an electrodeposition coating film portion that covers a surface of each of the at least two panel members, at least part of the electrodeposition coating film portion filling the clearance.

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**8 Claims, 5 Drawing Sheets**



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CPC ..... *B23K2201/18* (2013.01); *B23K 2203/04*  
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FIG. 1

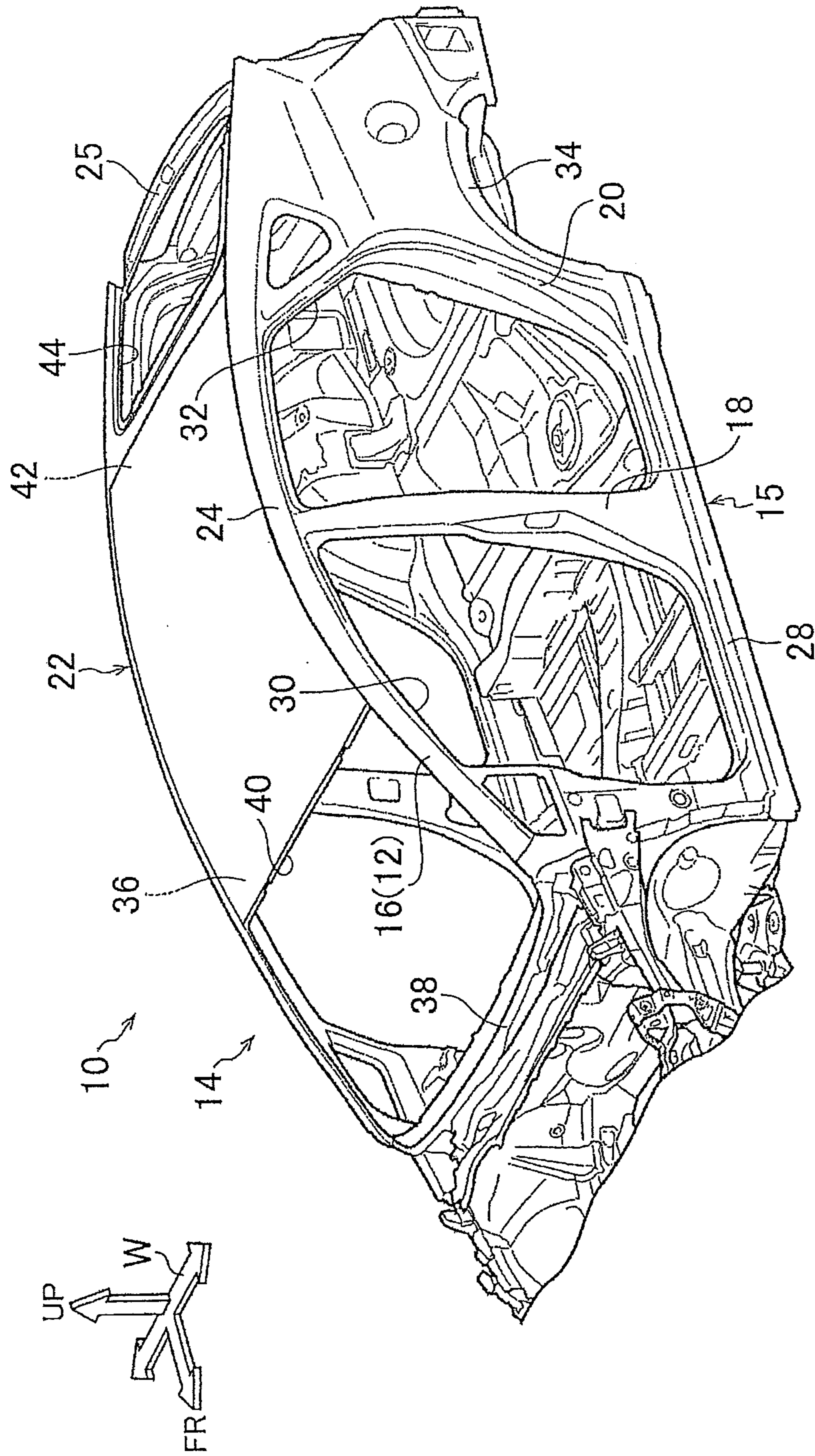




FIG. 2

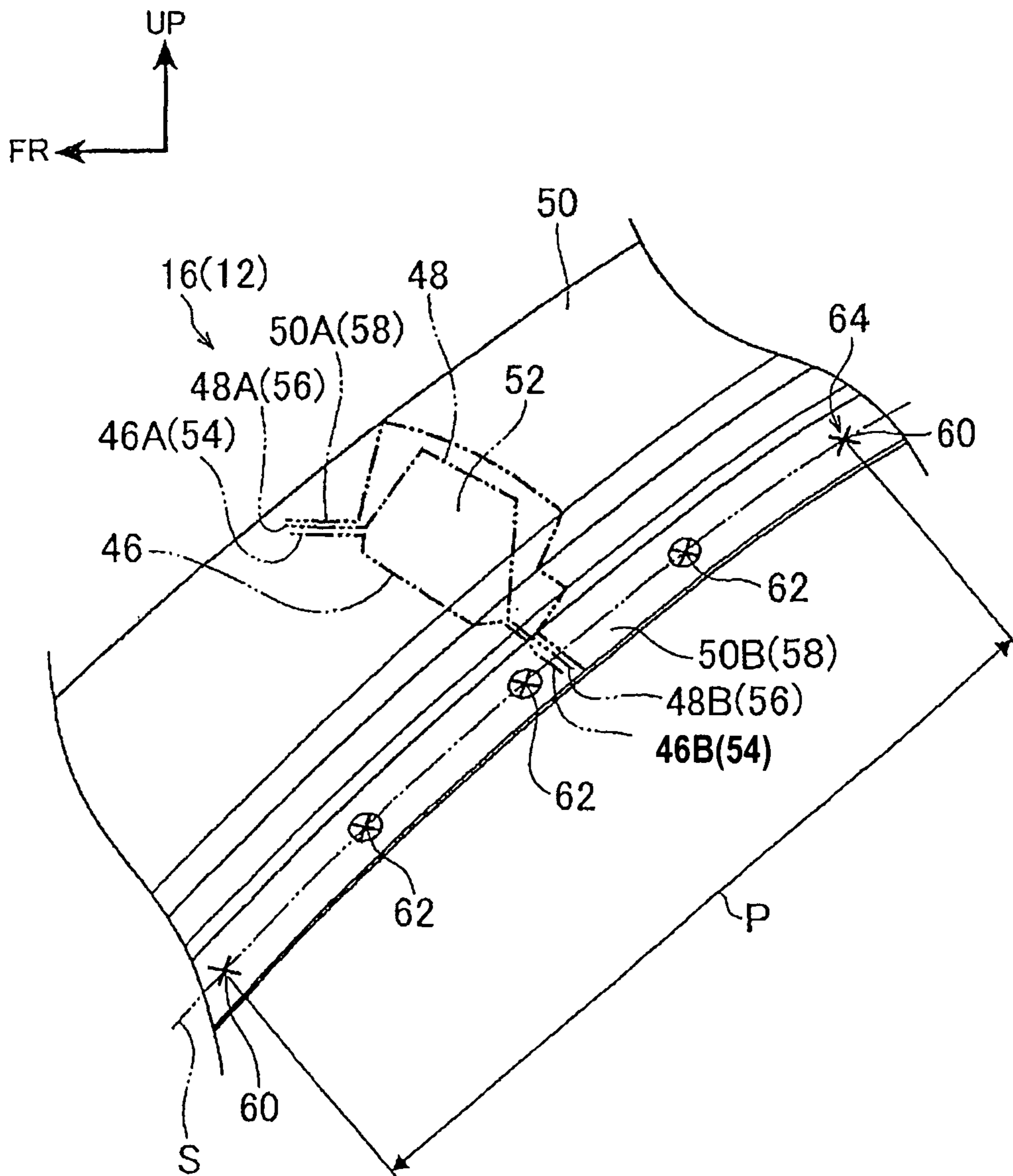


FIG. 3

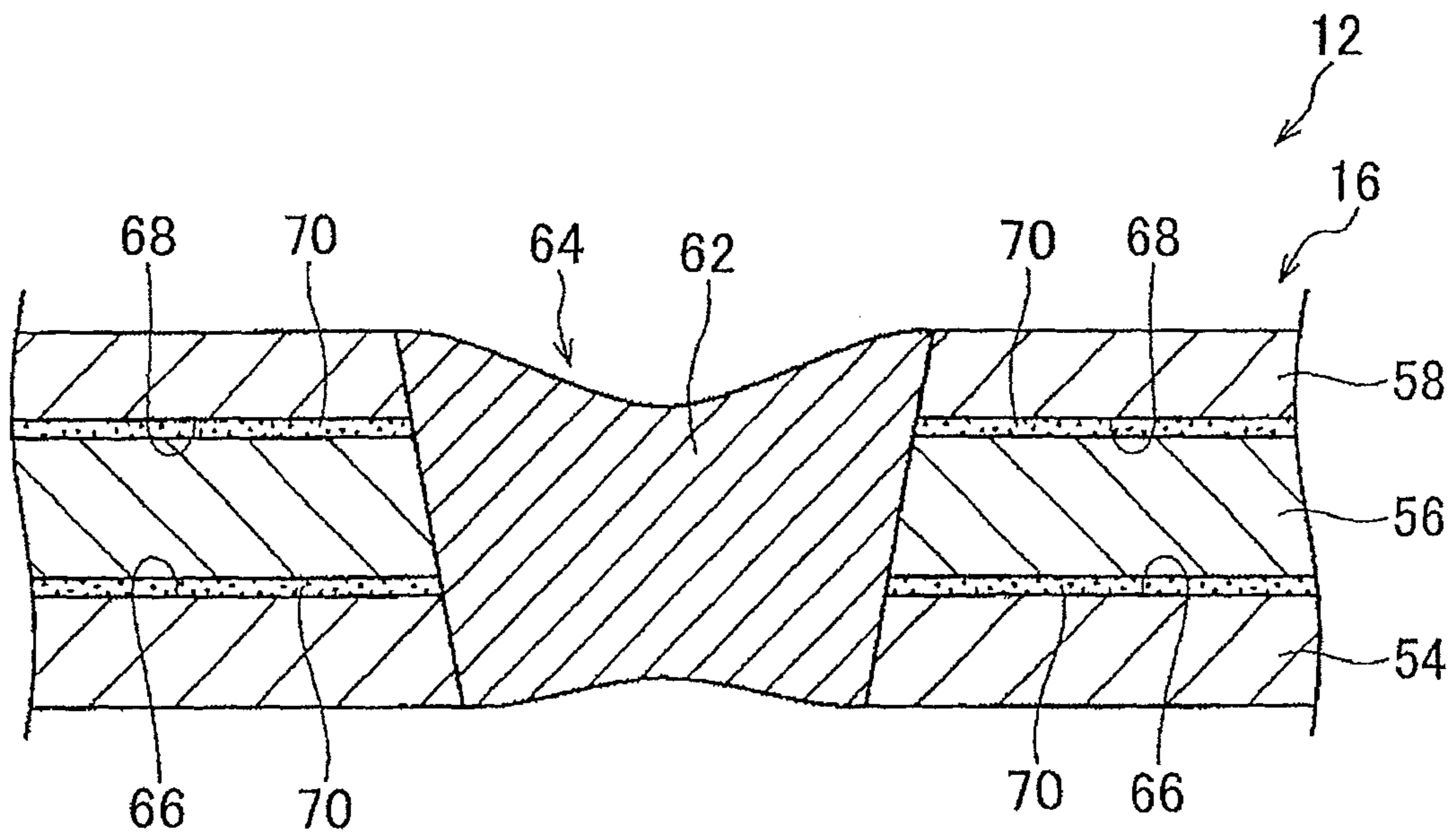


FIG. 4A

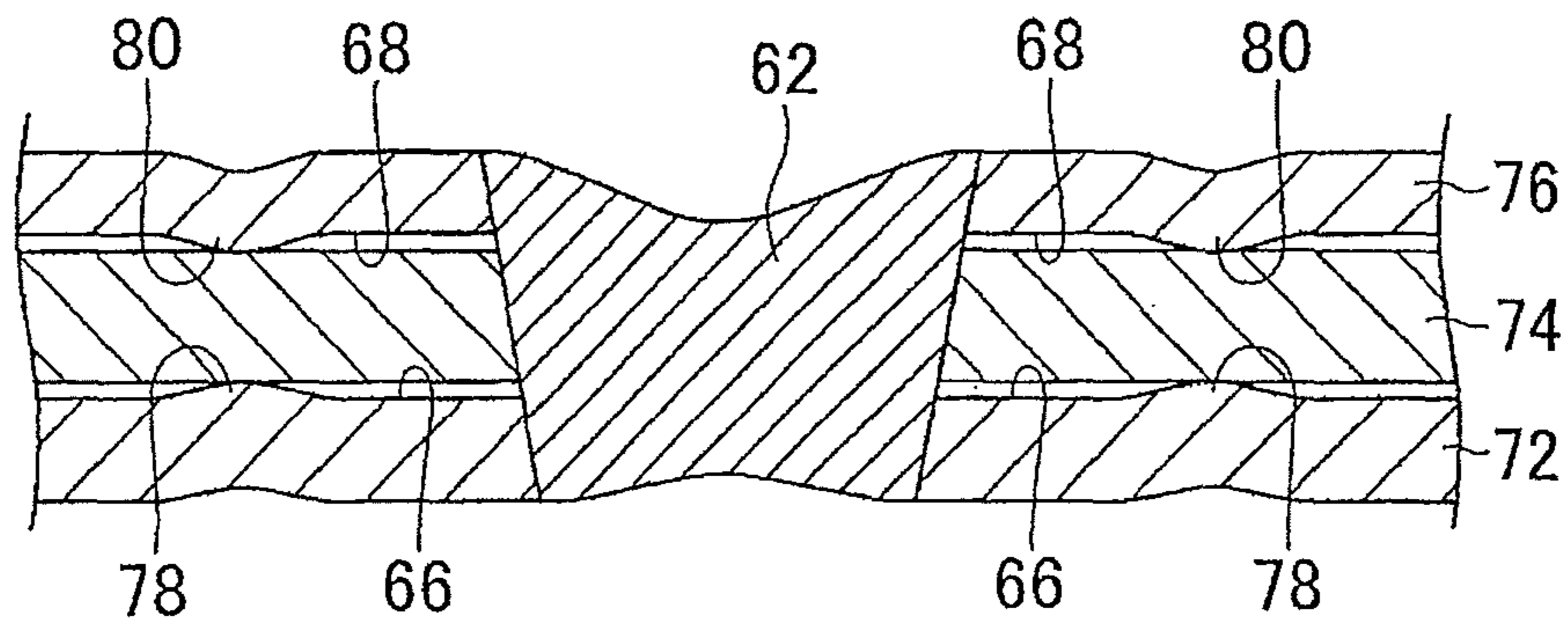


FIG. 4B

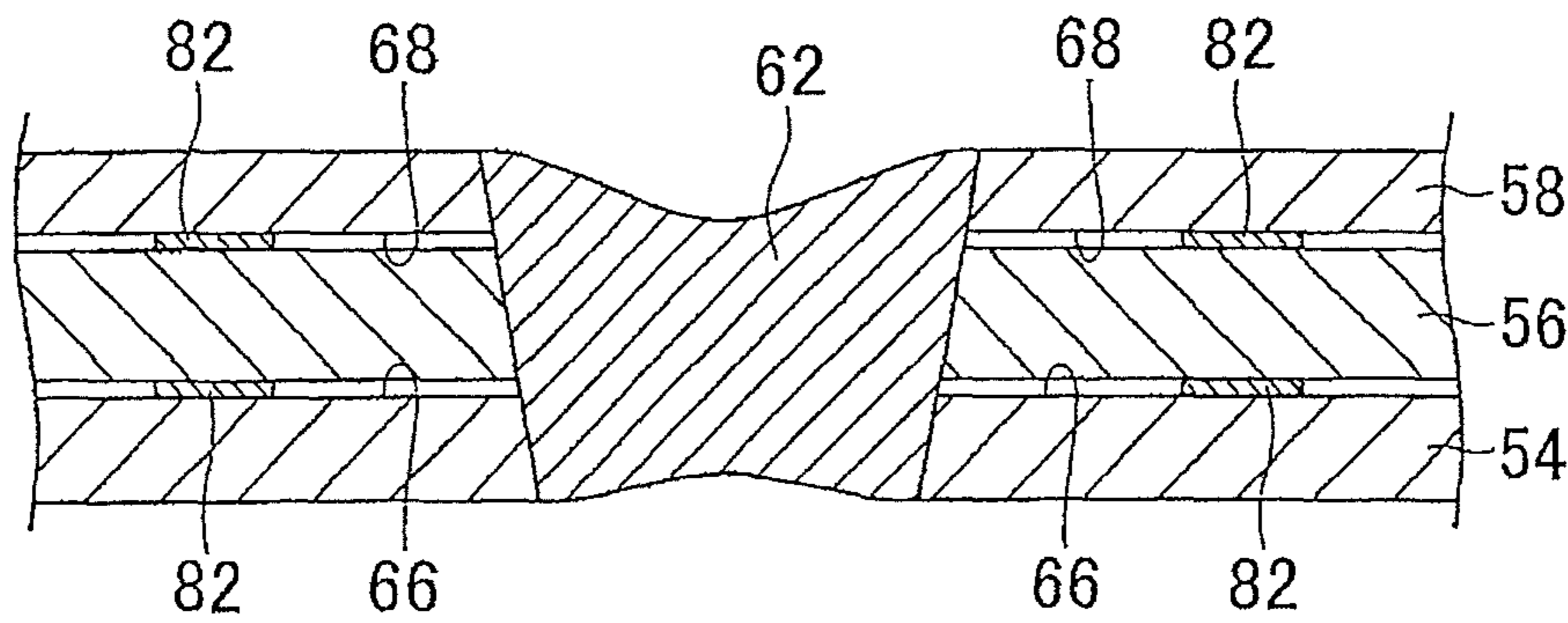
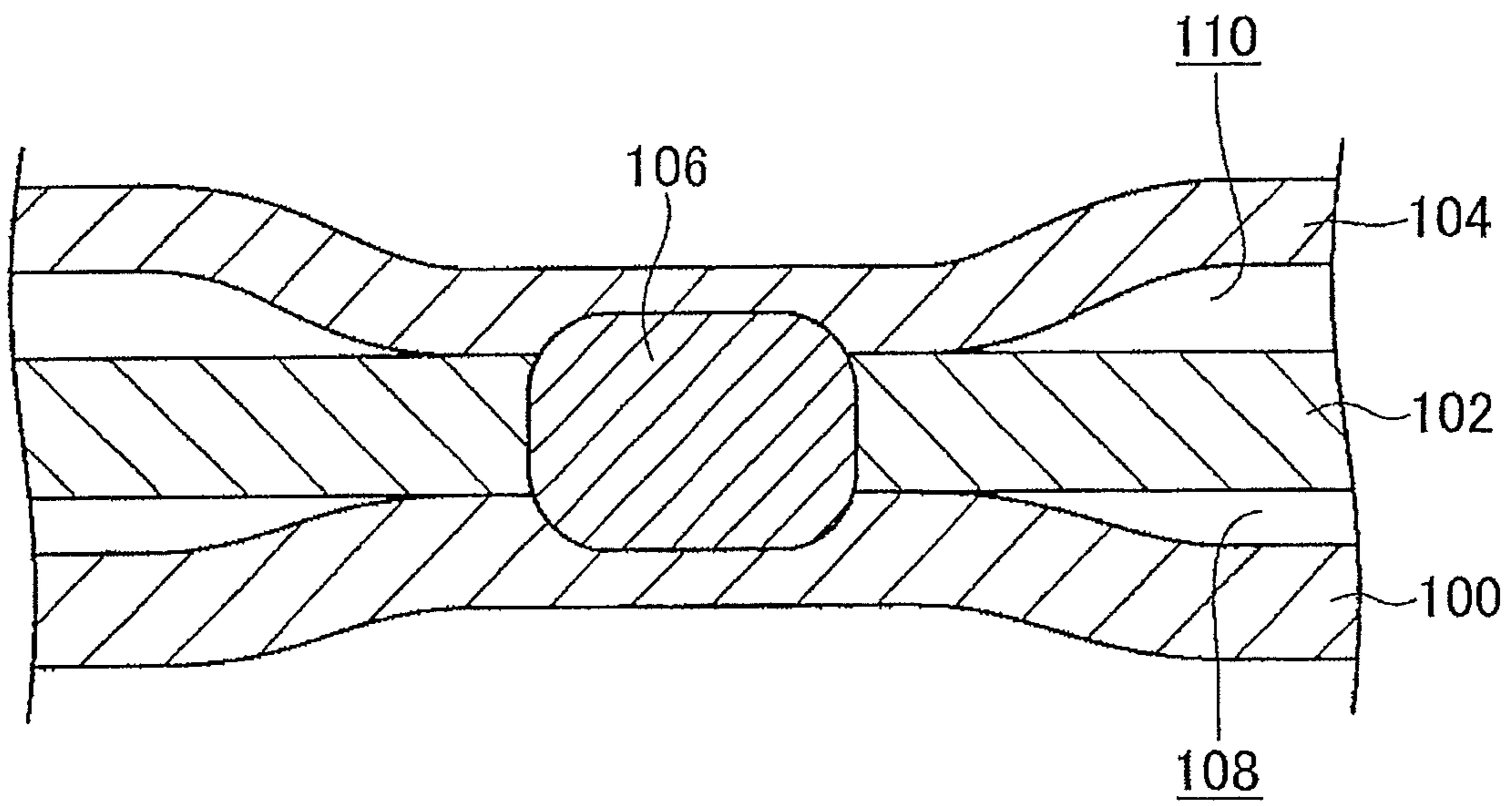


FIG. 5





## JOINT STRUCTURE FOR VEHICLE BODY MEMBER, AND VEHICLE BODY STRUCTURE

### INCORPORATION BY REFERENCE

The disclosure of Japanese Patent Application No. 2013-215569 filed on Oct. 16, 2013 including the specification, drawings and abstract is incorporated herein by reference in its entirety.

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

The invention relates to a joint structure for a vehicle body member, and a vehicle body structure.

#### 2. Description of Related Art

For example, Japanese Patent No. 3223746 describes a technique for forming a vehicle frame having a closed section by spot-welding a flange of an inner member (panel member) and a flange of an outer member (panel member) together. Here, in order to increase the stiffness of the frame, the spot interval of spot-welds is narrowed.

However, generally, the clearance between the inner member and the outer member is close to zero around each spot-weld. Therefore, there is a possibility that an ED coating solution (electrodeposition coating, anticorrosive base coat) does not enter the clearance. In this case, a bonding effect caused by ED coating is not obtained.

### SUMMARY OF THE INVENTION

The invention provides a joint structure for a vehicle body member and a vehicle body structure, which provide a bonding effect caused by electrodeposition coating.

An aspect of the invention provides a joint structure for a vehicle body member. The vehicle body member includes at least two panel members. The at least two panel members constitute part of a vehicle body, and are formed of a steel plate. The joint structure includes: spot-welds formed by spot-welding the at least two panel members to each other at a predetermined spot interval such that a predetermined clearance is formed between the at least two panel members; a laser-weld formed by laser-welding the at least two panel members to each other between the spot-welds; and an electrodeposition coating film portion that covers a surface of each of the at least two panel members, at least part of the electrodeposition coating film portion filling the clearance.

In the joint structure according to the above aspect, the at least two panel members formed of a steel plate are joined to each other by the spot-welds formed by spot welding and the laser-weld formed by laser welding.

The spot-welds are provided at the predetermined spot interval such that the predetermined clearance is formed between the panel members. By managing the spot interval of spot welding, it is possible to provide the predetermined interval between the panel members. The electrodeposition coating solution enters the clearance to cause the electrodeposition coating film to adhere to the surfaces of the panel members, thus covering the surfaces of the panel members.

The at least part of the electrodeposition coating film fills the clearance formed between the panel members. Thus, a bonding effect caused by the electrodeposition coating is obtained between the panel members. The laser-weld is provided between the spot-welds. In the case of laser welding, it is possible to join the panel members to each other in a state where the clearance formed by spot welding is maintained.

That is, with the joint structure according to the above aspect, by spot-welding the panel members at the predetermined spot interval to form the predetermined clearance between the panel members, a bonding effect caused by the electrodeposition coating film is obtained.

Another aspect of the invention provides a joint structure for a vehicle body member. The vehicle body member includes at least two panel members. The at least two panel members constitute part of a vehicle body, and are formed of a steel plate. The joint structure includes: spot-welds formed by spot-welding the at least two panel members to each other in a state where a predetermined clearance is formed between the at least two panel members; a laser-weld formed by laser-welding the at least two panel members to each other between the spot-welds; and an electrodeposition coating film portion that covers a surface of each of the at least two panel members, at least part of the electrodeposition coating film portion filling the clearance.

In the joint structure according to the above aspect, the at least two panel members formed of a steel plate are joined to each other by the spot-welds formed by spot welding and the laser-weld formed by laser welding.

The spot-welds are provided in a state where the predetermined clearance is formed between the panel members. By providing the predetermined clearance between the panel members, the electrodeposition coating solution enters the clearance to cause the electrodeposition coating film to adhere to the surfaces of the panel members, thus covering the surfaces of the panel members.

The at least part of the electrodeposition coating film fills the clearance formed between the panel members. Thus, a bonding effect caused by the electrodeposition coating is obtained between the panel members. The laser-weld is provided between the spot-welds. In the case of laser welding, it is possible to join the panel members to each other in a state where the clearance is maintained. That is, with the joint structure according to the above aspect, by joining the panel members to each other in a state where the predetermined clearance is formed, a bonding effect caused by the electrodeposition coating film is obtained.

In the joint structure according to the above aspect, a plurality of the laser-welds may be provided between the spot-welds.

With the joint structure according to the above aspect, the plurality of laser-welds are provided between the spot-welds, so it is possible to increase the spot interval of the spot-welds accordingly. That is, with the joint structure according to the above aspect, by laser-welding the panel members at multiple portions between the spot-welds, it is possible to compensate for a decrease in the stiffness of the joint structure for a vehicle body member, which arises as a result of an increase in the spot interval.

In the joint structure according to the above aspect, the laser-weld and the spot-welds may be provided along the same straight line.

With the joint structure according to the above aspect, because the laser-weld and the spot-welds are provided along the same straight line, it is possible to stabilize the size of the clearance formed between the panel members. That is, with the joint structure according to the above aspect, it is possible to stabilize a bonding effect caused by the electrodeposition coating between the panel members.

In the joint structure according to the above aspect, the predetermined clearance may be provided by a protrusion formed in the at least two panel members.

With the joint structure according to the above aspect, because the predetermined clearance is provided by the pro-



trusion formed between the panel members, in comparison with the case where a spacer is arranged in order to provide the predetermined clearance, it is possible to reduce cost by the amount by which the spacer is not required. That is, the joint structure according to the above aspect is able to reduce cost

The joint structure according to the above aspect may be applied to a vehicle body member of an upper body that constitutes a vehicle body upper part.

With the joint structure according to the aspect of the invention, the stiffness of the vehicle body member is ensured. Therefore, with the vehicle body structure according to the above aspect, by applying the joint structure according to the aspect of the invention to the vehicle body member of the upper body that constitutes the vehicle body upper part, it is possible to ensure steering stability. That is, with the vehicle body structure according to the above aspect, it is possible to ensure the steering stability of the vehicle by ensuring the stiffness of the upper body.

In the vehicle body structure according to the above aspect, the vehicle body member of the upper body may be a corner of a door opening in the upper body.

The door opening in the upper body is formed in a final joining process in welding of the joint structure, so the door opening significantly influences steering stability. Therefore, in the vehicle body structure according to the above aspect, the joint structure according to the invention is applied to the corner of the door opening in the upper body. That is, with the vehicle body structure according to the above aspect, it is possible to ensure the steering stability of the vehicle by ensuring the stiffness of the opening in the upper body.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Features, advantages, and technical and industrial significance of exemplary embodiments of the invention will be described below with reference to the accompanying drawings, in which like numerals denote like elements, and wherein:

FIG. 1 is a perspective view of an upper body to which a joint structure for a vehicle body member according to an embodiment is applied;

FIG. 2 is a perspective view that shows a relevant portion of a front pillar to which the joint structure for a vehicle body member according to the embodiment is applied;

FIG. 3 is a cross-sectional view that shows a relevant portion of the front pillar to which the joint structure for a vehicle body member according to the embodiment is applied;

FIG. 4A is a joint structure for a vehicle body member according to an alternative embodiment to the embodiment, and is a cross-sectional view corresponding to FIG. 3;

FIG. 4B is a joint structure for a vehicle body member according to an alternative embodiment to the embodiment, and is a cross-sectional view corresponding to FIG. 3; and

FIG. 5 is a comparative embodiment, and is a cross-sectional view corresponding to FIG. 3.

#### DETAILED DESCRIPTION OF EMBODIMENTS

A joint structure for a vehicle body member according to an embodiment of the invention will be described with reference to the accompanying drawings. The arrow FR indicates a front side in a vehicle longitudinal direction. The arrow W indicates a vehicle width direction. The arrow UP indicates an upper side in a vehicle up-down direction. In the following description, unless otherwise specified, when a longitudinal direction or an up-down direction is used, the longitudinal

direction means the vehicle longitudinal direction, and the up-down direction means the vehicle up-down direction.

As shown in FIG. 1, a joint structure 12 for a vehicle body member according to the present embodiment is, for example, applied to an upper body 14 of a vehicle body 10. A front pillar 16, a center pillar 18 and a rear pillar 20 are provided upright in the stated order from the vehicle front side at each vehicle body side portion 15 of the upper body 14. Each of these front pillar 16, center pillar 18 and rear pillar 20 is a columnar vehicle body frame member of which a closed sectional portion is formed of at least two panel members (described later) and is provided upright in substantially the vehicle up-down direction.

Upper end portions of the front pillar 16 and center pillar 18 are connected to a roof side rail 24. The roof side rail 24 is arranged in the vehicle longitudinal direction at each side portion of a vehicle roof portion 22 in the vehicle width direction. A roof panel 36 is provided on the inner side of each roof side rail 24 in the vehicle width direction.

Lower end portions of the front pillar 16 and center pillar 18 are connected to a locker 28. The locker 28 is arranged in the vehicle longitudinal direction at each side of a vehicle floor portion (not shown) in the vehicle width direction. Each of these roof side rail 24 and locker 28 is a vehicle body frame member of which a closed sectional portion is formed of at least two panel members and is extended in the vehicle longitudinal direction.

On the other hand, a substantially rectangular front door opening 30 is formed at a front side of a center portion of each vehicle body side portion 15. The front door opening 30 is surrounded by the front pillar 16, the center pillar 18, the roof side rail 24 and the locker 28. The front door opening 30 is opened or closed by a front side door (not shown).

A substantially rectangular rear door opening 32 is formed at a rear side of the center portion of each vehicle body side portion 15. The rear door opening 32 is surrounded by the center pillar 18, the rear pillar 20, the roof side rail 24 and the locker 28. The rear door opening 32 is opened or closed by a rear side door (not shown). A rear wheel house portion 34 is provided on a vehicle rear side to the rear pillar 20.

In addition, a substantially rectangular front windshield opening 40 is formed at a front end portion of the vehicle roof portion 22. The front windshield opening 40 is surrounded by a front header portion 36, the front pillars 16 and a cowl portion 38 that are arranged in the vehicle width direction. A front windshield (not shown) is fitted to the front windshield opening 40.

A substantially rectangular back door opening 44 is formed at a rear end portion of the vehicle roof portion 22. The back door opening 44 is surrounded by a rear header portion 42, the rear pillars 20 and a lower back portion 25 that are arranged in the vehicle width direction. A back door (not shown) is fitted to the back door opening 44.

For example, the front pillar 16 will be described as panel members according to the embodiment by way of example. As shown in FIG. 2, the front pillar 16 includes an inner reinforcement 46, an outer reinforcement 48 and a side member outer 50. The upper end side of the front pillar 16 is shown.

Each of the inner reinforcement 46, the outer reinforcement 48 and the side member outer 50 is formed of a long steel sheet. The inner reinforcement 46 has a hat shape in which a plane cross-sectional shape in the width direction perpendicular to the longitudinal direction is open outward in the vehicle width direction. The outer reinforcement 48 is provided on the outer side of the inner reinforcement 46 in the vehicle width direction. The outer reinforcement 48 has a hat



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shape in which a plane cross-sectional shape in the width direction perpendicular to the longitudinal direction is open inward in the vehicle width direction. The side member outer **50** is provided on the outer side of the outer reinforcement **48** in the vehicle width direction. The side member outer **50** has a hat shape in which a plane cross-sectional shape in the width direction perpendicular to the longitudinal direction is open inward in the vehicle width direction.

A front flange portion **46A** is provided at the front end of the inner reinforcement **46**. A rear flange portion **46B** is provided at the rear end of the inner reinforcement **46**. A front flange portion **48A** is provided at the front end of the outer reinforcement **48**. A rear flange portion **48B** is provided at the rear end of the outer reinforcement **48**. In addition, a front flange portion **50A** is provided at the front end of the side member outer **50**, and a rear flange portion **50B** is provided at the rear end of the side member outer **50**.

In the inner reinforcement **46**, the outer reinforcement **48** and the side member outer **50**, the front flange portions **46A**, **48A**, **50A** are laid over and joined to one another, and the rear flange portions **46B**, **48B**, **50B** are laid over and joined to one another. Thus, a closed sectional portion **52** is formed in the front pillar **16**.

Hereinafter, for the sake of convenience of description, description will be made on the assumption that a panel member **54** includes the front flange portion **46A** and the rear flange portion **46B**, a panel member **56** includes the front flange portion **48A** and the rear flange portion **48B** and a panel member **58** includes the front flange portion **50A** and the rear flange portion **50B**.

These panel members **54**, **56**, **58** are joined to one another by spot welding and laser welding. Laser welding includes laser screw welding (LSW), linear laser welding, and the like.

Spot welding has a spot interval P of, for example, about 100 to 300 mm (spot-welds **60**). Laser welding is applied at multiple portions (laser-welds **62**) between the spot-welds **60**. The spot-welds **60** and the laser-welds **62** are respectively welded so as to be arranged along substantially the same straight line S (joint **64**). The joint **64** is provided at the side of the closed sectional portion **52** of the front pillar **16** in the panel members **54**, **56**, **58**.

After the panel members **54**, **56**, **58** are joined to one another, electrodeposition coating (so-called ED coating) is applied to the vehicle body including the front pillar **16**. Although not shown in the drawing, the vehicle body is immersed in a bath filled with electrodeposition paint, voltage is applied between the vehicle body and an electrode in the bath, and a coating film is precipitated by energization. After that, the vehicle body is raised from the bath, redundant paint is removed by washing the vehicle body with water, and the process of hardening the paint is performed. Because the electrodeposition coating is base coating, finish coating for decorative purposes will be applied to the vehicle body.

Next, the operation and advantageous effects of the above-described joint structure for a vehicle body member will be described.

As shown in FIG. 2, the panel members **54**, **56**, **58** in the front pillar **16** are joined to one another by spot welding and laser welding. The spot-welds **60** are provided at the predetermined spot interval P (here, about 100 to 300 mm) such that a predetermined clearance **66** (see FIG. 3) is formed between the panel member **54** and the panel member **56** and a predetermined clearance (see FIG. 3) is formed between the panel member **56** and the panel member **58**.

Generally, although not shown in the drawing, the spot interval is about 50 mm. This is because, when the spot interval is too narrow, heat is not generated and, as a result, the

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panel members may not be able to be welded to one another; whereas, when the spot interval is too wide, the number of spot-welds is small and, as a result, the stiffness may not be sufficiently ensured. On the other hand, in the case of spot welding, the panel members are welded to one another by passing current between a pair of spot guns while the panel members are held and pressed by the pair of spot guns.

Therefore, as shown in FIG. 5, a panel member **100**, a panel member **102** and a panel member **104** are pressed by the spot guns to be deformed and pressure-welded to one another. Thus, there is a possibility that, around a spot-weld **106**, no clearance is provided between the panel member **100** and the panel member **102** or between the panel member **102** and the panel member **104**. In this way, when no clearance is provided, an electrodeposition coating solution does not enter around the spot-weld **106**.

On the other hand, when slightly distanced from the spot-weld **106**, a clearance **108** is provided between the panel member **100** and the panel member **102**, and a clearance **110** is provided between the panel member **102** and the panel member **104**. At the spot-weld **106**, the panel members **100**, **102**, **104** are pressed by the spot guns to be deformed, so the clearances **108**, **110** increase as compared to those in the case where the panel members **100**, **102**, **104** are not deformed.

Thus, there is a possibility that an electrodeposition coating film adhered to the surfaces of the panel member **100** and panel member **102** does not fill the clearance **108** or an electrodeposition coating film adhered to the surfaces of the panel member **102** and panel member **104** does not fill the clearance **110**. In this case, a bonding effect caused by the electrodeposition coating film is not expected between the panel members **100**, **102** and between the panel members **102**, **104**.

In contrast, as shown in FIG. 2, in the present embodiment, the spot interval P of spot welding is wider (about 100 to 300 mm) than that in the existing spot welding. By managing the spot interval P of spot welding, the predetermined clearance **66** is allowed to be provided between the panel member **54** and the panel member **56**, and the predetermined clearance **68** is allowed to be provided between the panel member **56** and the panel member **58** (described later), as shown in FIG. 3.

An electrodeposition coating solution is allowed to enter the clearances **66**, **68**. Thus, it is possible to cause the electrodeposition coating solution to adhere to the surfaces of the panel members **54**, **56**, **58**, and it is possible to cover the surfaces of the panel members **54**, **56**, **58** with the electrodeposition coating films. Thus, an anticorrosive effect improves in the front pillar **16**.

When the electrodeposition coating solution hardens, a similar effect to that of a so-called adhesive agent is obtained, and connection of the joint **64** becomes tight in the front pillar **16**. Accordingly, the stiffness of the front pillar **16** increases. In the present embodiment, when the electrodeposition coating solution enters the predetermined clearances **66**, **68** set by managing the spot interval P of spot welding, the clearance between the panel member **54** and the panel member **56** and the clearance between the panel member **56** and the panel member **58** are filled with the electrodeposition coating films (electrodeposition coating film portions **70**). The predetermined clearances **66**, **68** are, for example, about 0.1 to 0.3 mm.

Thus, because of the electrodeposition coating film portions **70**, a bonding effect is obtained between the panel member **54** and the panel member **56** and between the panel member **56** and the panel member **58**. Thus, no structural adhesive agent is required at portions at which the elec-



trodeposition coating film portions 70 are formed, so it is possible to reduce cost by the amount by which the structural adhesive agent is not used.

In addition, as shown in FIG. 2, laser welding is applied at multiple portions between the spot-welds 60 (laser-welds 62). In the case of laser welding, it is possible to join the panel members 54, 56, 58 with one another in a state where the clearances 66, 68 (see FIG. 3) formed by spot welding are maintained. By applying laser welding instead of spot welding, it is possible to increase the spot interval P of the spot-welds 60 in a state where the stiffness of the front pillar 16 is ensured.

In this way, by reducing the number of spot-welds 60, it is possible to reduce the portions that the electrodeposition coating solution does not enter, so an anticorrosive effect further improves in the front pillar 16. By applying laser welding at multiple portions between the spot-welds 60, it is possible to compensate for a decrease in the stiffness of the front pillar 16, which arises as a result of an increase in the spot interval P.

The laser-welds 62 and the spot-welds 60 are welded such that the laser-welds 62 and the spot-welds 60 are arranged along substantially the same straight line (the joint 64 is arranged along the straight line S). Thus, the certain clearance 66 (see FIG. 3) is obtained between the panel Member 54 and the panel member 56, and the certain clearance 68 (see FIG. 3) is obtained between the panel member 56 and the panel member 58. Thus, it is possible to stabilize a bonding effect caused by the electrodeposition coating between the panel member 54 and the panel member 56 and between the panel member 56 and the panel member 58.

Furthermore, the joint 64 is provided at the side of the closed sectional portion 52 of the front pillar 16 in the panel members 54, 56, 58. Thus, although not shown in the drawing, in comparison with the case where the joint 64 is provided at an outer periphery side (at a side away from the closed sectional portion 52), it is possible to suppress peeling between the panel member 54 and the panel member 56 and between the panel member 56 and the panel member 58 at the time when an impact load is input.

As shown in FIG. 3, in the present embodiment, the electrodeposition coating film portions 70 are respectively formed to fill the entire clearance 66 between the panel member 54 and the panel member 56 and the entire clearance between the panel member 56 and the panel member 58. Instead, at least part of the electrodeposition coating film portion 70 just needs to fill the clearance 66 or at least part of the electrodeposition coating film portion 70 just needs to fill the clearance 68.

In the present embodiment, the spot-welds 60 are provided at the predetermined spot interval P (see FIG. 2) such that the predetermined clearance 66 is formed between the panel member 54 and the panel member 56 and the predetermined clearance 68 is formed between the panel member 56 and the panel member 58; however, setting of the predetermined clearances 66, 68 is not limited to this configuration.

For example, as shown in FIG. 4A, predetermined clearances may be set by providing a panel member 72 with guide locations 78 and providing a panel member 76 with guide locations 80. The guide locations 78, 80 serve as protrusions that protrude in a circular arc shape toward a panel member 74. Specifically, the predetermined clearance 66 is set by the height of each guide location 78, and the predetermined clearance 68 is set by the height of each guide location 80. In this case, in comparison with the case where spacers are arranged

in order to provide the predetermined clearances 66, 68, it is possible to reduce cost by the amount by which the spacers are not required.

As shown in FIG. 4B, plate-shaped metal shim jigs 82 may be inserted between the panel member 54 and the panel member 56 and between the panel member 56 and the panel member 58. The predetermined clearances 66, 68 are set by the thickness of each of the shim jigs 82; however, the shim jigs 82 are removed after completion of welding.

In the present embodiment, the front pillar 16 is described; however, the invention is, of course, applicable to the center pillar 18 and the rear pillar 20 shown in FIG. 1. In the present embodiment, joining of three panel members is described. Instead, the invention may also be applied to joining of two panel members.

The joint structure for a vehicle body member according to the present embodiment is applicable to vehicle body members, other than pillars, in the upper body 14. Those vehicle body members other than pillars, for example, include the cowl portion 38, the rear wheel house portions 34, the front door openings 30, the rear door openings 32, the front windshield opening 40, the back door opening 44, and the like. By applying the joint structure for a vehicle body member according to the present embodiment to these vehicle body members, it is possible to improve the stiffness of the upper body 14 and to ensure the steering stability of the vehicle.

The openings, such as the front door openings 30 and the rear door openings 32, are formed in a final joining process in welding of the joint structure for a vehicle body member, so the openings significantly influence the steering stability of the vehicle. Therefore, by applying the joint structure for a vehicle body member according to the present embodiment to corners of the front door openings 30, rear door openings 32, and the like, in the upper body 14, it is possible to improve the stiffness of the front door openings 30, rear door openings 32, and the like, in the upper body 14 and to further ensure the steering stability of the vehicle. The invention may also be applied to an under body in a vehicle body structure according to the present embodiment.

One embodiment of the invention is described above; however, the invention is not limited to the above-described embodiment. Of course, the invention may be implemented in various forms other than the above-described embodiment without departing from the scope of the invention.

What is claimed is:

1. A joint structure for a vehicle body member, the vehicle body member including at least two panel members, the at least two panel members constituting part of a vehicle body and being formed of a steel plate, the joint structure comprising:

- spot-welds formed by spot-welding the at least two panel members to each other at a predetermined spot interval such that a predetermined clearance is formed between the at least two panel members;
  - a plurality of laser-welds formed by laser-welding the at least two panel members to each other between the spot-welds such that each of the plurality of laser-welds and the spot-welds are not in direct contact with each other; and
  - an electrodeposition coating film portion that covers a surface of each of the at least two panel members, at least part of the electrodeposition coating film portion filling the clearance,
- wherein the laser-welds and the spot-welds are arranged along the same straight line, the straight line intersecting a center of both the laser-welds and the spot-welds.



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2. A vehicle body structure comprising:  
the joint structure according to claim 1, the joint structure  
being applied to a vehicle body member of an upper  
body that constitutes a vehicle body upper part.
3. The vehicle body structure according to claim 2, wherein 5  
the vehicle body member of the upper body is a corner of a  
door opening in the upper body.
4. A joint structure for a vehicle body member, the vehicle  
body member including at least two panel members, the at  
least two panel members constituting part of a vehicle body 10  
and being formed of a steel plate, the joint structure compris-  
ing:  
spot-welds formed by spot-welding the at least two panel  
members to each other in a state where a predetermined 15  
clearance is formed between the at least two panel mem-  
bers;  
a plurality of laser-welds formed by laser-welding the at  
least two panel members to each other between the spot-  
welds such that each of the plurality of laser-welds and 20  
the spot-welds are not in direct contact with each other;  
and

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- an electrodeposition coating film portion that covers a sur-  
face of each of the at least two panel members, at least  
part of the electrodeposition coating film portion filling  
the clearance,
- wherein the laser-welds and the spot-welds are arranged  
along the same straight line, the straight line intersecting  
a center of both the laser-welds and the spot-welds.
5. The joint structure according to claim 4, wherein  
the predetermined clearance is provided by a protrusion  
formed in the at least two panel members.
6. The joint structure according to claim 4, wherein  
the predetermined clearance is provided by a shim jig that  
is inserted between the at least two panel members and  
that is removed after spot welding.
7. A vehicle body structure comprising:  
the joint structure according to claim 6, the joint structure  
being applied to a vehicle body member of an upper  
body that constitutes a vehicle body upper part.
8. The vehicle body structure according to claim 7, wherein  
the vehicle body structure is applied to a corner of a door  
opening in the upper body.

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